Site Design Checklist
and
LID Calculations Worksheet

Edition: 10/7/2003

SECTION A: SITE DESIGN CHECKLIST

Prior to developing any structural stormwater practices on a site, significant reductions in stormwater quantity and quality impacts can be made through enhancements to site design. Below is a checklist of site design and planning practices that can be used to minimize stormwater impacts. Please check the practices that you are applying to your development, and note the extent to which each selected practices was implemented.

Site Design Technique 1:
Minimize direct stormwater impacts to streams and wetlands to the maximum extent practicable. This can be accomplished by siting stormwater facilities outside of streams and wetlands, maintaining natural drainages, and preserving riparian buffers.

Achieved	Not Achieved	Practice
		Stormwater facilities located outside of streams and wetlands
		Natural drainage routes maintained on site.
		Riparian buffers preserved
		Distributed “Integrated Management Practices” used in lieu of centralized ponds

Describe actions taken:

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Site Design Technique 2:
Preserve the natural cover on as much of the site as possible, especially for areas located on hydrologic soil groups (HSG) A and B.
Natural vegetation helps maintain and preseve predevelopment hydrology on a site, thereby reducing the reliance on large-scale stormwater ponds. Natural cover on highly permeable soils increases filtration and infiltration.

Achieved	Not Achieved	Practice
		Utilize clustered development designs that preserve a significant portion of the site in a natural state.
		Utilize “fingerprint” clearing…limit the clearing and grading of forests and native vegetation to the minimum area needed for the construction of the lots, the provision of necessary access, and fire protection.
		Avoid impacts to wetlands or vegetated riparian buffers
		A & B Soils preserved in natural cover .

Describe actions taken:

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Site Design Technique 3:
Minimize the overall impervious cover.
Roadways, sidewalks, driveways and parking areas are the greatest sources of site imperviousness. Impervious areas alter runoff and recharge values and site hydrology. For LID sites, managing the imperviousness contributed by road and parking area pavement is an important component of the site planning and design process. There are several methods that can be used to achieve a reduction in the total runoff volume from impervious surfaces.

Achieved	Not Achieved	Practice
		Utilize the minimum required width for streets and roads.
		Utilize street layouts that reduce the number of homes per unit length
		Minimize cul-de-sac diameters, use doughnut cul-de-sacs, or use alternative turnarounds
		Minimize excess parking space construction, utilize pervious pavers in low-use parking areas
		Utilize structured or shared parking
		Reduce home setbacks and frontages
		Where permitted, minimize sidewalk construction by utilizing sidewalks on one side only, utilizing “skinny” sidewalks, or substituting sidewalks with pervious trails through common greenspace.
		Substitute pervious surfaces for impervious wherever possible
		Where permitted, avoid the use of curb and gutter. Utilize vegetated open swales, preferably “engineered swales” with a permeable soil base.
		Minimize compaction of the landscape. In areas where soils will become compacted due to construction equipment, specify that the soils will be “disked” prior to seeding, and amended with loam or sand to increase absorption capacity.

Describe actions taken:
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____
____

Site Design Technique 4:
Locate infiltration practices on HSG A and B soils wherever possible.
HSG A & B soils are valuable resources on a site for facilitating infiltration of the increased runoff volume. Every effort should be made to utilize areas with these soils for IMPs that promote infiltration.
☐ Achieved
☐ Not Achieved:
Describe actions taken:
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Site Design Technique 5:
Locate impervious areas on less permeable soils (HSG C and D).
Placement of impervious areas on lower permeability soils minimizes the the potential loss of infiltration/recharge capacity on the site.

- [ ] Achieved
- [ ] Not Achieved

Describe actions taken:

____
____
____

Site Design Technique 6:
"Disconnect" impervious areas.
"Disconnecting" means having impervious cover drain to pervious cover, i.e. downspouts draining to the yard, not the driveway. This decreases both the runoff volume and Time of Concentration. Disconnected parking lots, for example, can provide sheet flow into bioretention areas or engineered infiltration swales.

- [ ] Achieved
- [ ] Not Achieved

Describe actions taken:

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Site Design Technique 7:
Increase the travel time of water off of the site (Time of Concentration)
Replicating the pre-development Time of Concentration is a key aspect in maintaining pre-development flow regime, and minimizing downstream impacts.

Achieved	Not Achieved	Practice
		Flatten grades for stormwater conveyance to the minimum sufficient to allow positive drainage.
		Increase the travel time in vegetated swales by using more circuitous flow routes, rougher vegetation in swales, and check dams.
		Utilize "engineered" swales in lieu of pipes or hardened channels. These swales will have shallow grades and will have a sand or gravel substrate below the sod to promote infiltration.

Describe actions taken:

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____
____

Site Design Technique 8:
Utilize soil management/enhancement techniques to increase soil absorbtion

Achieved	Not Achieved	Practice
		Delineate soils on site for the preservation of infiltration capacity. Mark these areas in the field and restrict heavy equipment access.
		Require compacted soils in areas receiving sheetflow runoff (such as yards, downslope of downspouts) will be "disked" and amended with loam or sand prior to seeding/sodding.

Site Design Technique 10:
Revegetate all cleared and graded areas.
Revegetating graded areas, planting, or preserving existing vegetation can reduce hydrologic impacts by creating added surface roughness as well as providing for additional volume storage.

☐ Achieved

☐ Not Achieved

Describe actions taken:

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Site Design Technique 12:
Use "engineered swales" for conveyance in lieu of curbe and gutter wherever possible. Engineered swales utilize a sand substrate to maximize infiltration. Maintaining the predevelopment time of concentration (Tc) minimizes the increase of the peak runoff rate after development by lengthening flow paths and reducing the length of the runoff conveyance systems.

☐ Achieved

☐ Not Achieved

Describe actions taken:

____
____
____

Site Design Technique 13:
Utilize level spreading of flow into natural open space. Wherever buffers or other areas of open space are preserved, ensure that they are made hydrologically functional by making them receiving areas for sheet flow, not concentrated flow. Use level spreaders on lot or pavement edges to help spread water into the preserved areas. Ensure that flow volumes do not cause channelized flow and erosion in receiving buffers.

☐ Achieved

☐ Not Achieved

Describe actions taken:

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____
____

Much of the above is excerpted from the Prince George's County, Md., 1999 *Low Impact Development Design Strategies: An Integrated Design Approach*. Largo, Maryland. (See References) All planned LID techniques should conform to the designs of those presented in this manual. Descriptions of the above and other site design techniques can be found in the LID references listed in aforementioned manual.

SECTION B: LID Calculations Worksheet

Definitions

Low Impact Development (LID) – An approach to site design and stormwater management that seeks to maintain the site's pre-development rates and volumes of runoff. LID accomplishes this through the minimization of impervious cover, strategic placement of buildings, pavement and landscaping, and the use of small-scale distributed runoff management features that are collectively called "Integrated Management Practices" (IMPs).

Detention – The collection of runoff in a ponding area, depression, or storage chamber followed by its gradual release through an outlet into a receiving water body. Detention is one way to reduce a site's peak runoff rate to its pre-development peak rate for the storm event of a given magnitude, but is not an effective way to reduce the runoff volume.

Retention – The collection of runoff in a ponding area or receptacle where it is kept until it soaks into the ground through infiltration. Retention reduces the volume of runoff from a site and can also be effective in reducing the peak runoff rate if the retention volume is sufficiently large.

Time of Concentration (Tc) – The time for runoff to travel from the hydraulically most distant point of the development site to the watershed outlet or study point.

Instructions

Before beginning the LID Calculations Worksheet, **first evaluate your site design using the Site Design Checklist**. The use of the site design practices is a critical component in ensuring that the pre-development hydrology on a site can be maintained.

The following worksheet follows the process detailed in *LID Hydrologic Analysis* (see references). Designers should download a copy from the internet to assist in the completion of this worksheet.

Note: Development projects that are unable to create sufficient retention practices to maintain the predevelopment runoff volume should revisit the application of the site design practices to the site. The thorough use of site design practices will reduce post-development curve numbers, and can result in decreased stormwater detention and retention volume requirements. Additionally, modifications to the design of bioretention practices, such as the inclusion of a gravel sump, can provide additional storage volume).

Determining the LID Runoff Curve Number

(LID Hydrologic Analysis, pg 22-25)

a. Calculate pre-development Curve Number (CN) and Time of Concentration (Tc) using TR-55 or other suitable method.

   CN_{pre} = ________
   Tc_{pre} = _______ minutes

b. For comparison purposes, calculate a composite curve number for the *developed site*, using the **conventional TR-55 approach**.

   $CN_{conventional}$ = _________

c. Calculate a composite **custom LID curve number** for the site, following the approach in Section 4.3 (pages 22-24) of "LID Hydrologic Analysis*". *This is much more detailed than the conventional Tr-55 approach.* This approach factors in the use of higher permeability soils for infiltration and the use of "disconnectedness" (impervious cover flowing to pervious cover). Use an R factor of "1" for bioretention practices.

   $CN_{conventional}$ = _______ (from above)
   CN_{LID} = ________

   Reduction in CN achieved with site design = ______ ($CN_{conventional}$ - CN_{LID})

d. Calculate the post-development Time of Concentration (Tc). Utilize the practices described in "LID Design Strategies"*, such as flattening grades, lengthening flow paths, etc to reduce the Tc to the predevelopment time.

   Tc_{pre} = _______
   Tc_{LID} = _______ (the Tc after maximizing practices to lengthen flow travel time)

NOTE: For the LID approach to function effectively, the Tc_{pre} must equal Tc_{LID}.
If Tc_{LID} is higher, <u>STOP here</u> and incorporate practices to reduce it.
See "LID Design Strategies" for details.

Step 1: Determine the Retention Volume Required to Maintain Pre-development Runoff Volume

a. Calculate the **Design Rainfall** for your site, per the procedure outlined on pages 36-38 of “LID Hydrologic Analysis*”. This is the rainfall at which runoff would have initiated on the site, if it were vegetated with “woods in good condition”.

If your calculated value for Design Rainfall is LESS THAN the 1-year 24 hour rainfall for your area, **USE the 1-year 24 hour rainfall instead.**

Design Rainfall = ______ in

b. Use the tables in Appendix A of the “LID Hydrologic Analysis*” to calculate inches of storage volume to **Maintain Predevelopment <u>Runoff Volume</u>** ***for your Design Rainfall***

Preliminary Retention Storage volume = _____ $in_{across\ entire\ site}$ = _____ ft^3

Step 2: Determine Storage Volume for Water Quality Protection

a. Per example 4.3, ensure that the Preliminary Retention Storage Volume (Step 1.b) meets or exceeds the **“Water Quality Volume”,** which is ½” or runoff from impervious areas on the site.

Preliminary Retention Storage Volume = ______ ft^3 (From Step 1.b) Water Quality Volume = ______ ft^3	Enter Higher → → → → Value	Retention Storage Volume = _________ ft^3

b. Following example 4.2 on page 29 of “LID Hydrologic Analysis*”, **calculate the area of IMP’s required** to be distributed evenly on the site to retain the Retention Storage Volume.

Bioretention Design Option	Area ft^2	% of site
6” ponding depth		
6” ponding depth + 12” gravel sump (= 10.8” total storage)		
8” ponding depth		
8” ponding depth + 12” gravel sump (= 12.8“ total storage)		
8” ponding depth + 18” gravel sump (= 15.2“ total storage)		
10” ponding depth + 18” gravel sump (= 17.2” total storage)		

*Gravel sump storage estimates assume #57 stone with 40% void space

Step 3: Determine the Storage Volume for Maintaining Peak Runoff Rate

Using the Charts in Appendix B of the "LID Hydrologic Analysis", determine the **storage volume** required to **maintain peak Runoff Rate using 100% RETENTION storage.** **(Use the chart for a Type II storm for with your design rainfall)**

Storage Volume $_{\text{Peak Rate Control}}$ *(using 100% Retention)* = ________ in (across entire site)
= ________ ft^3

Step 4: Evaluate Need for Additional Detention Storage (Hybrid Design)
Compare the volumes required for volume control and peak rate control:

If Retention Storage *Volume > Storage Volume*$_{\textit{peak rate control (100\% Retention)}}$…
Design site IMPs to retain (infiltrate) the Retention Storage Volume.
No additional detention is required.

If Retention Storage Volume < *Storage Volume*$_{\textit{peak rate control (100\% Retention)}}$…
*(or if **Retention Storage Volume** is unachievable with infiltration IMPs due to site contraints) then a HYBRID DESIGN IS REQUIRED.*
Follow Steps 5,6, & 7 on pages 34-37, of "LID Hydrologic Analysis" to calculate additional detention or retention required to meet peak runoff rate.
LID seeks to use distributed, micro-scale practices such as rain gardens, amended soils, green roofs, rain barrels, etc to retain this additional volume as well. If this is not practicable for the site, ponds can be used to detain the additional volume.

Additional detention required = _______ in (across entire site)
= _______ ft^3

Summary of Quantitative LID Results

Yes / No Site design and impervious cover reduction practices were used to the maximum extent practicable to minimize runoff volume.

Yes / No The design results in a post-development Tc equal to the pre-development Tc.

Yes / No The entire **Retention Storage Volume** will be retained and infiltrated.

Yes / No / NA If the entire **Retention Storage Volume** is not retained and infiltrated, the plans show that every practicable effort was made to implement runoff volume reduction efforts, and all potential green space areas were made hydrologically functional for retention.

Yes / No Detention practices were used to store any additional volume required to maintain the predevelopment peak rate.

References

1. ***Model Development Principles for the Central Rappahannock*** is available for download at http://for.communitypoint.org/pages/download.htm
2. **Low Impact Development National Manual. *Low-Impact Development Design Strategies An Integrated Design Approach.*** EPA 841-B-00-003. Available on the web at http://www.epa.gov/owow/nps/urban.html and via FTP at ftp://lowimpactdevelopment.org/pub/
3. **Low Impact Development National Hydrology Manual. *Low-Impact Development Hydrologic Analysis*.** EPA 841-B-00-002**.** Available on the web at http://www.epa.gov/owow/nps/urban.html and via FTP at ftp://lowimpactdevelopment.org/pub/
NOTE: The appendices to the hydrology document include a series of charts which are required to calculate LID storage volumes. They are not currently available in the downloadable version, but selected charts from that series are attached to the end of this document.

Selected Charts for Calculating LID Storage Volumes

taken from
"LID Hydrologic Analysis"
(Low Impact Development National Hydrology Manual)
Prince Georges County, Md. – June 2002
EPA 841-B-00-002

Charts Taken from

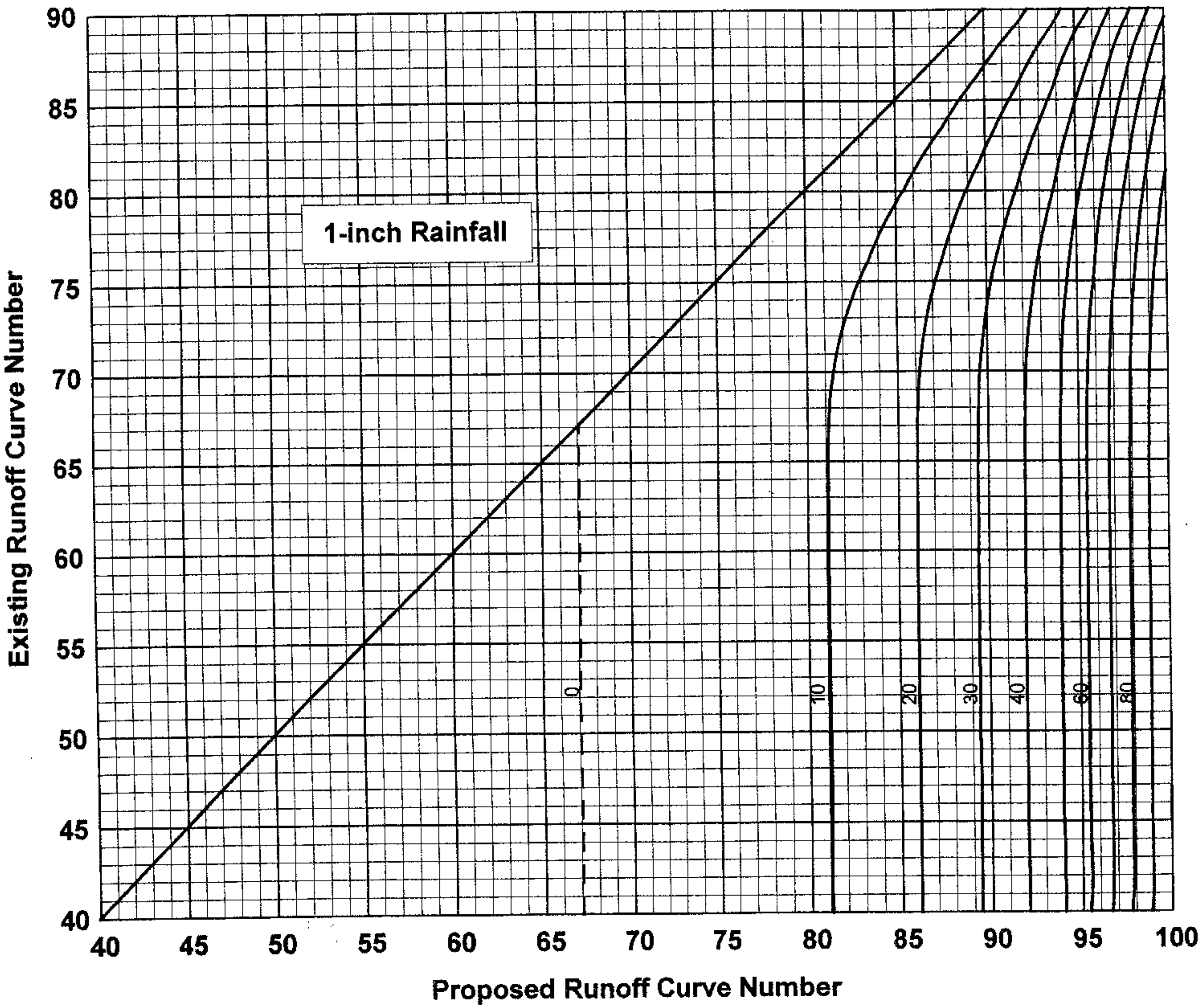
APPENDIX A

Of

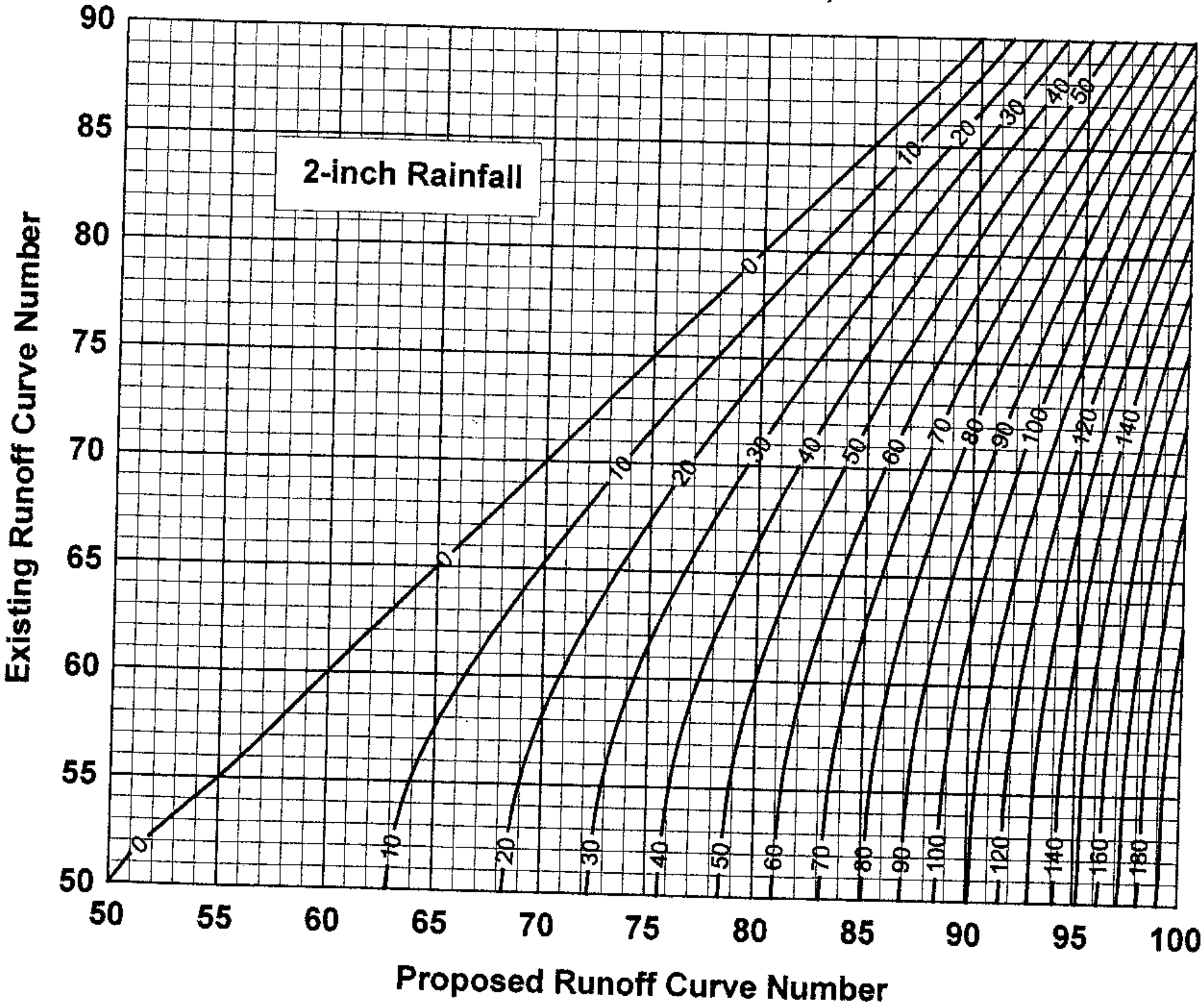
LID Hydrologic Analysis

"Storage Required to Maintain Pre-Development Runoff Volume"

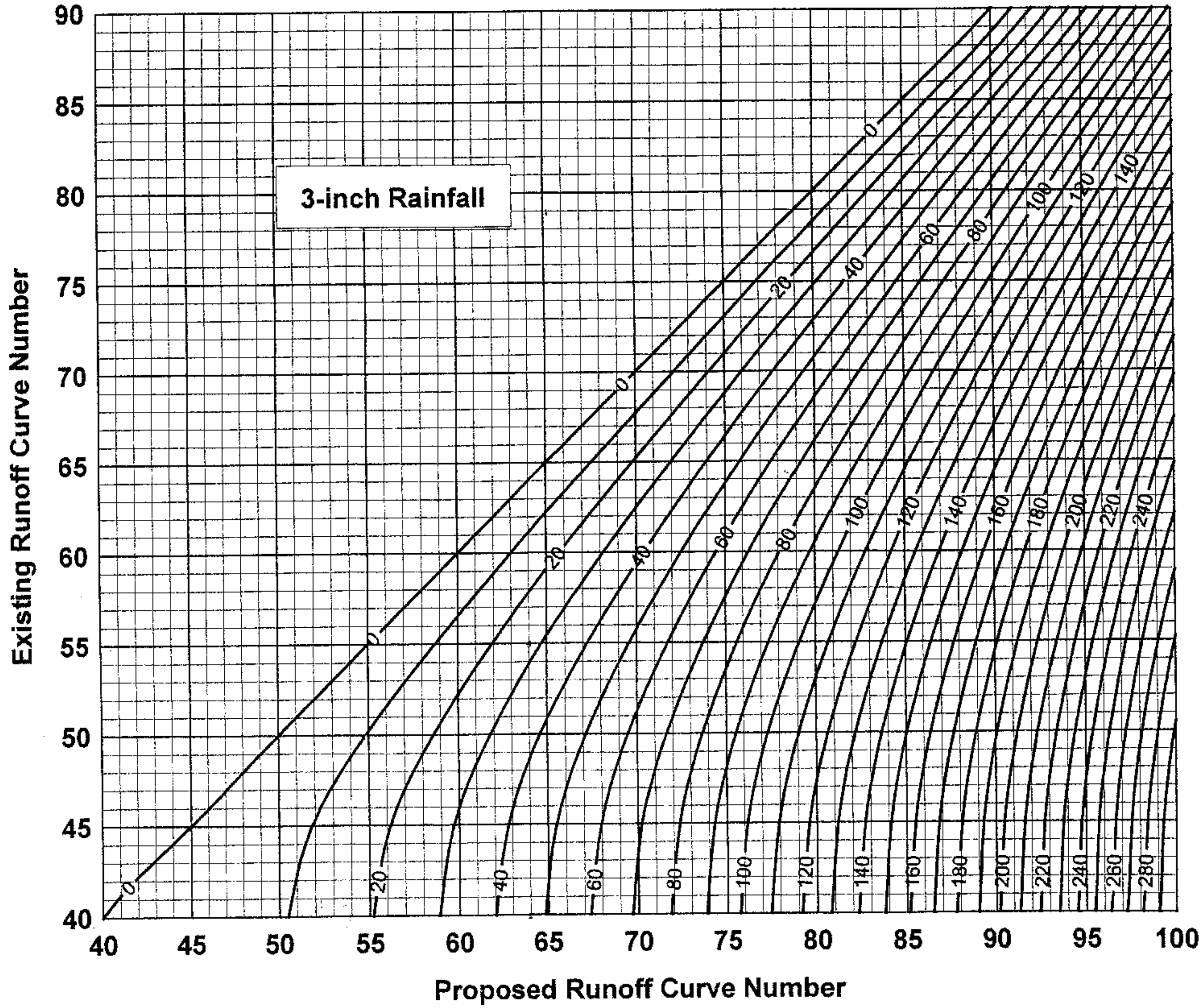
Storage Required to Maintain Pre-Development Runoff Volume (hundredths of an inch)



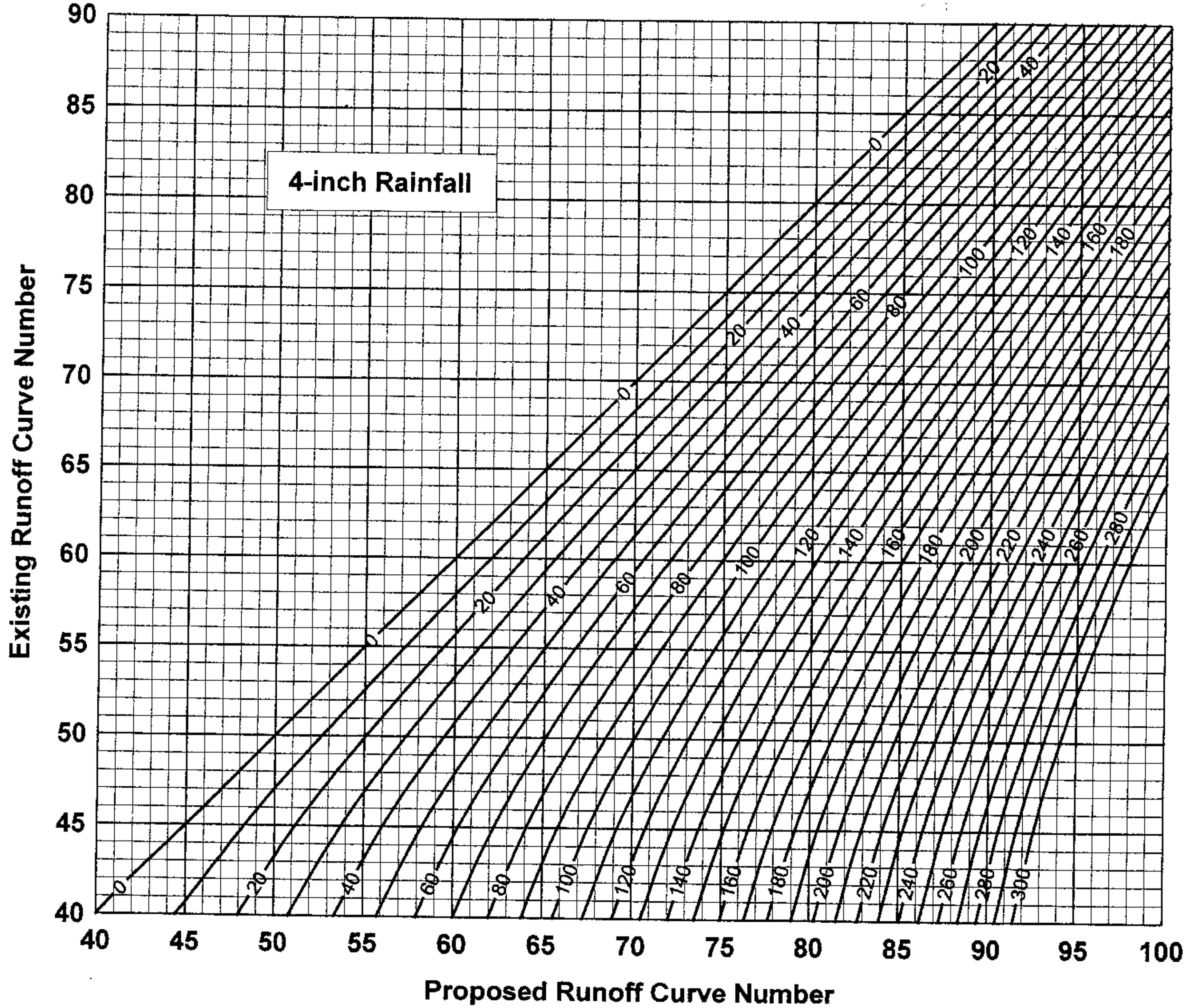
Storage Required to Maintain Pre-Development Runoff Volume (hundredths of an inch)



Storage Required to Maintain
Pre-Development Runoff Volume
(hundredths of an inch)



Storage Required to Maintain Pre-Development Runoff Volume (hundredths of an inch)



Charts Taken from

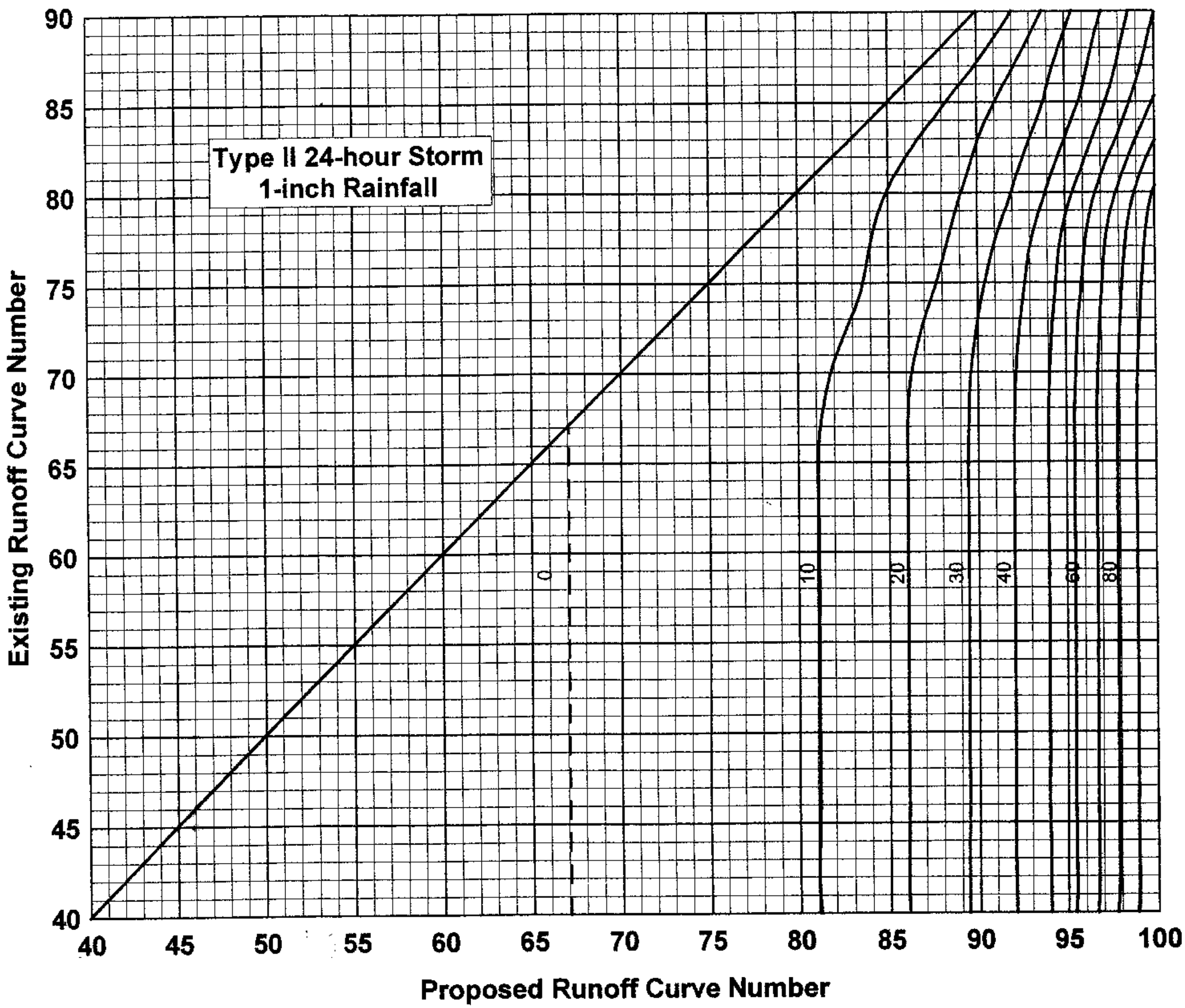
APPENDIX B

Of

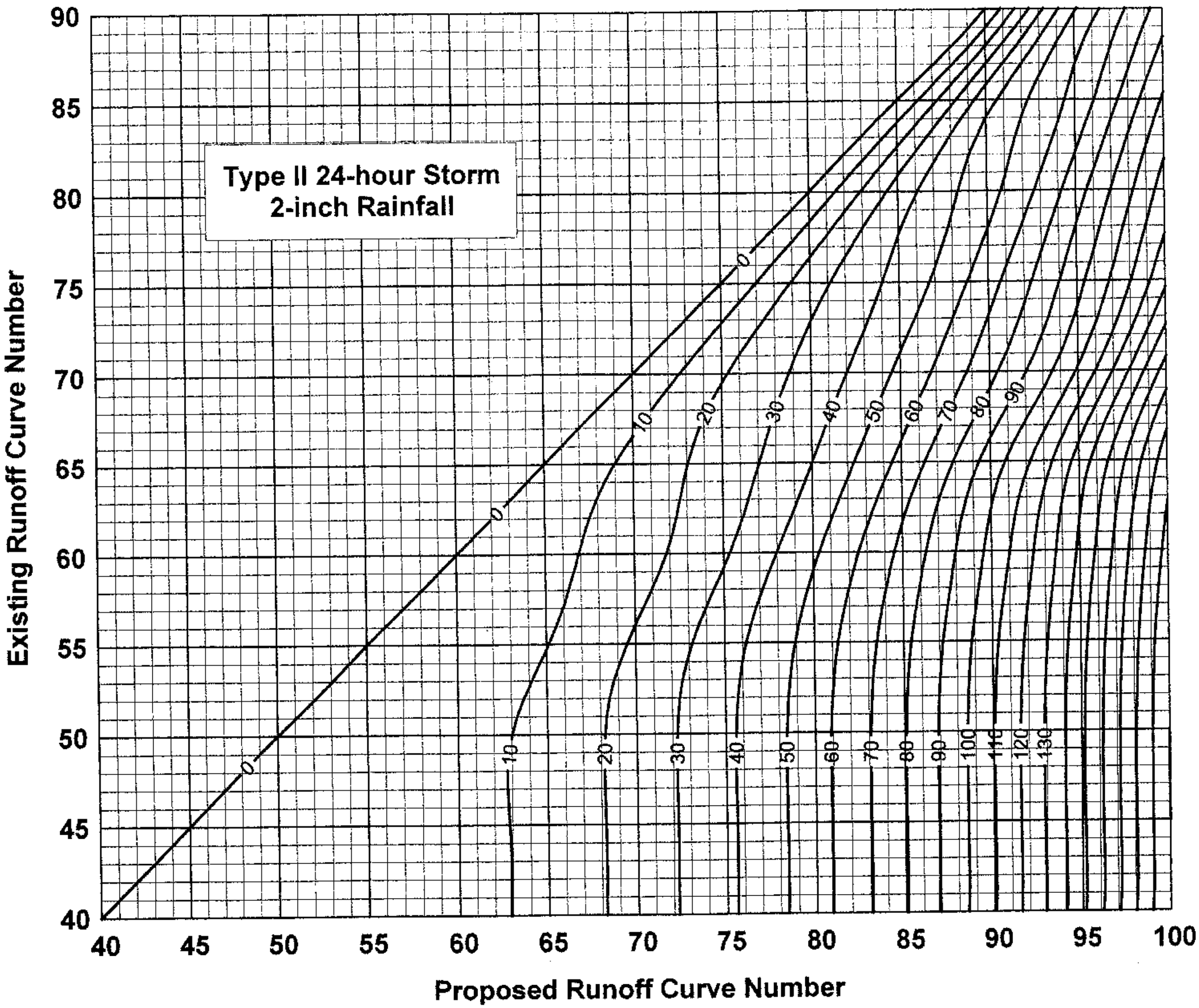
LID Hydrologic Analysis

"Storage Required to Maintain Peak Runoff using 100% Retention"

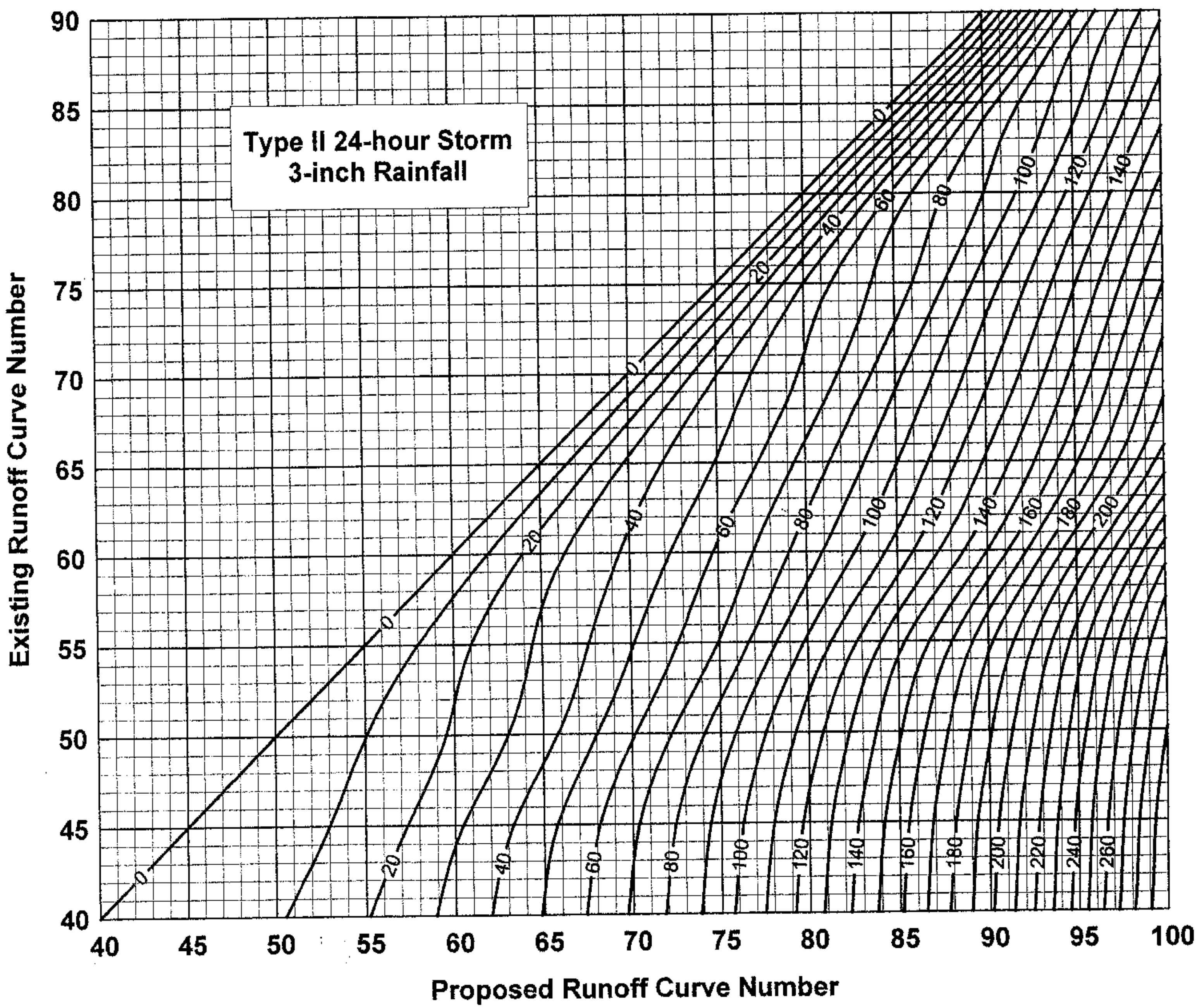
Storage Required to Maintain Pre-Development Peak Runoff Rate Using 100% Retention (hundredths of an inch)



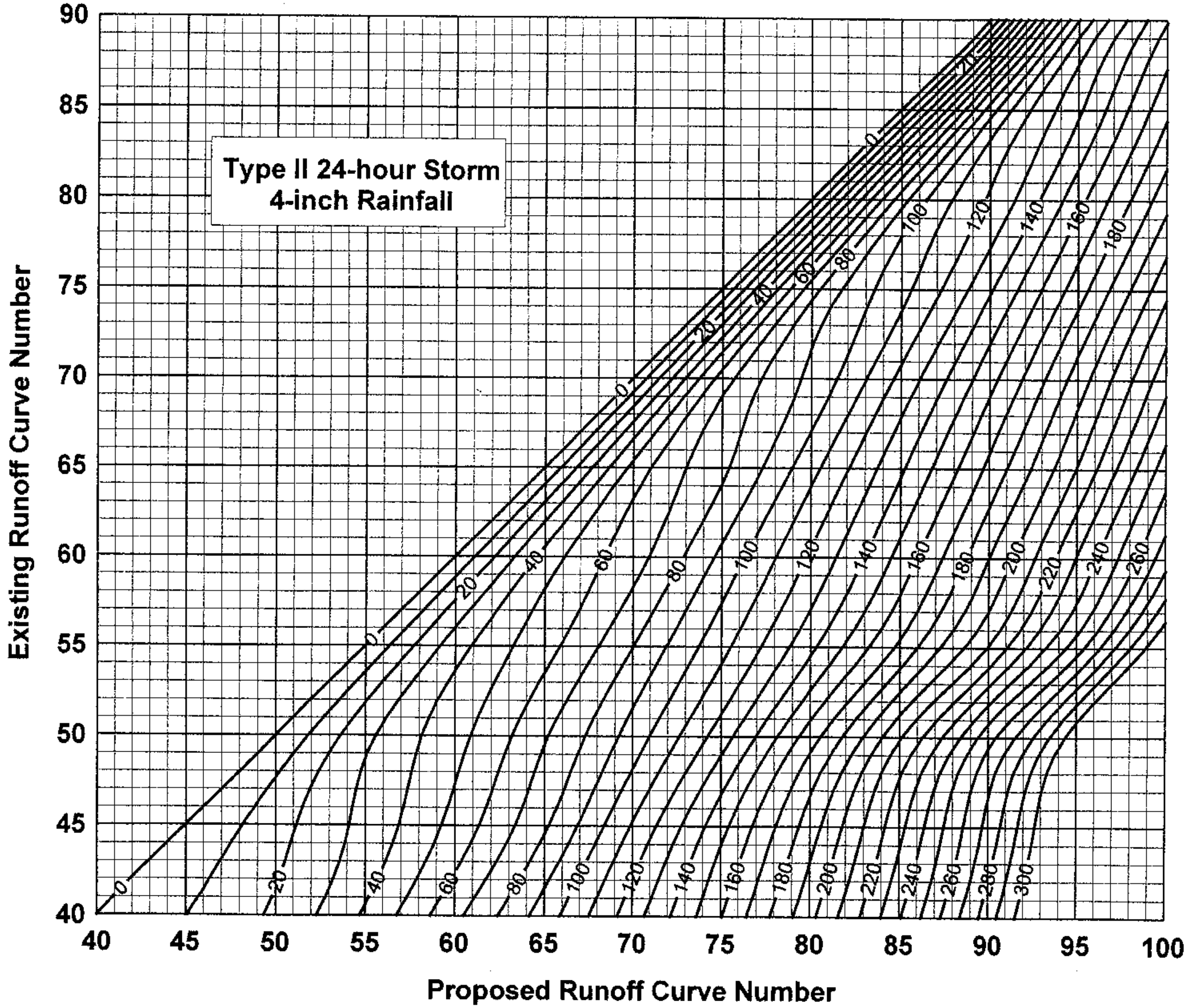
Storage Required to Maintain Pre-Development Peak Runoff Rate Using 100% Retention (hundredths of an inch)



Storage Required to Maintain Pre-Development Peak Runoff Rate Using 100% Retention (hundredths of an inch)



Storage Required to Maintain Pre-Development Peak Runoff Rate Using 100% Retention (hundredths of an inch)



Charts Taken from

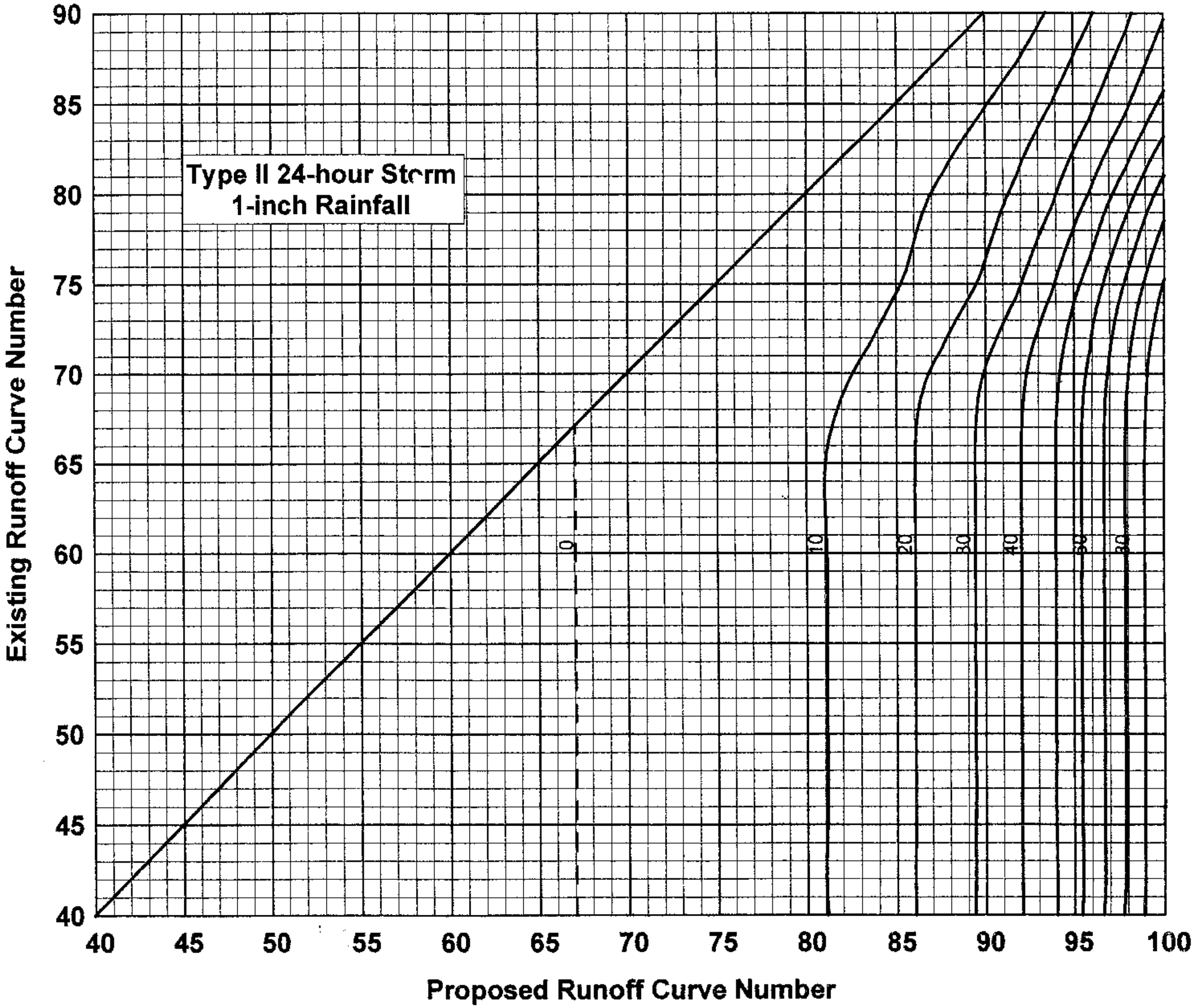
APPENDIX C

Of

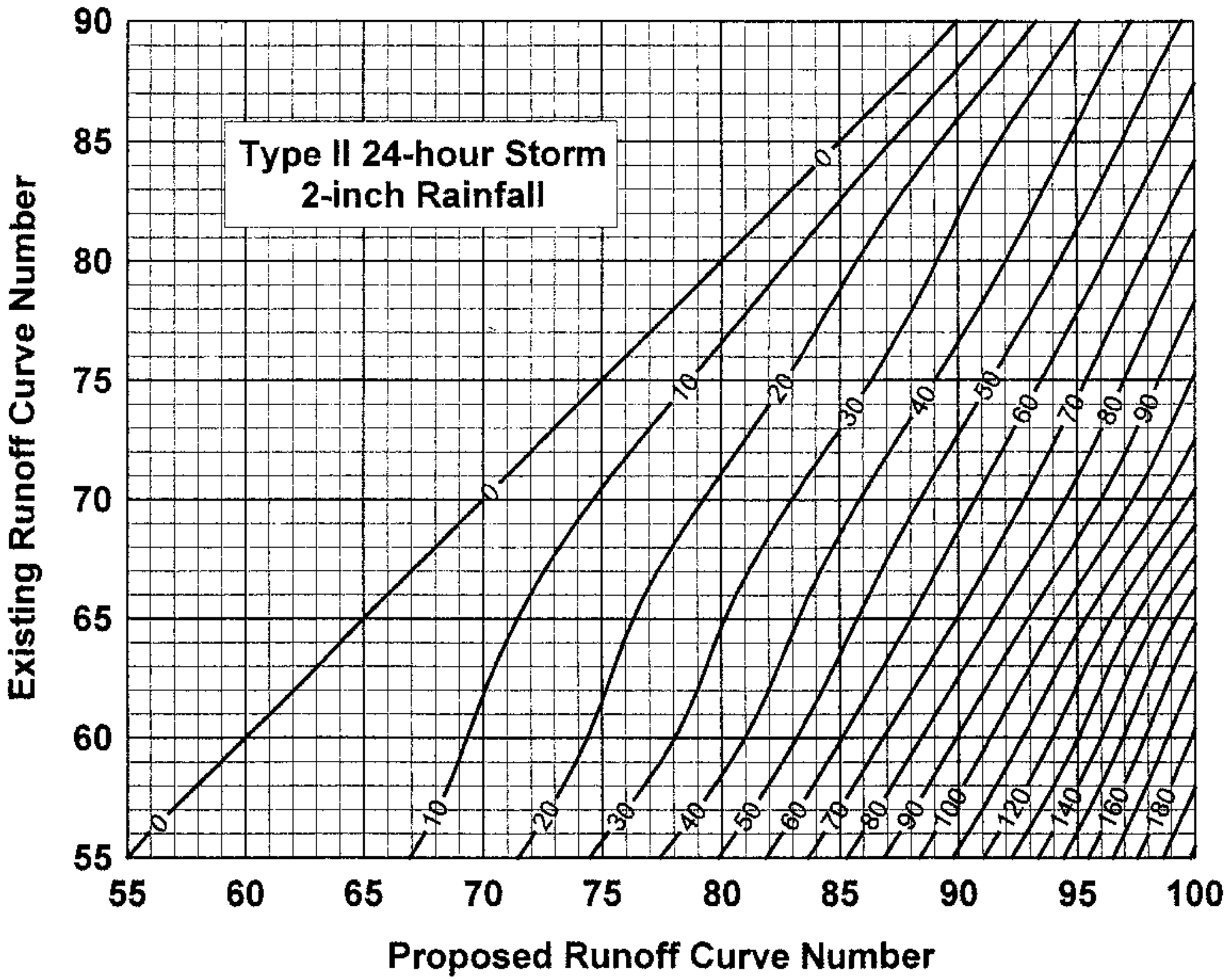
LID Hydrologic Analysis

“Storage Required to Maintain Peak Runoff using 100% Detention”

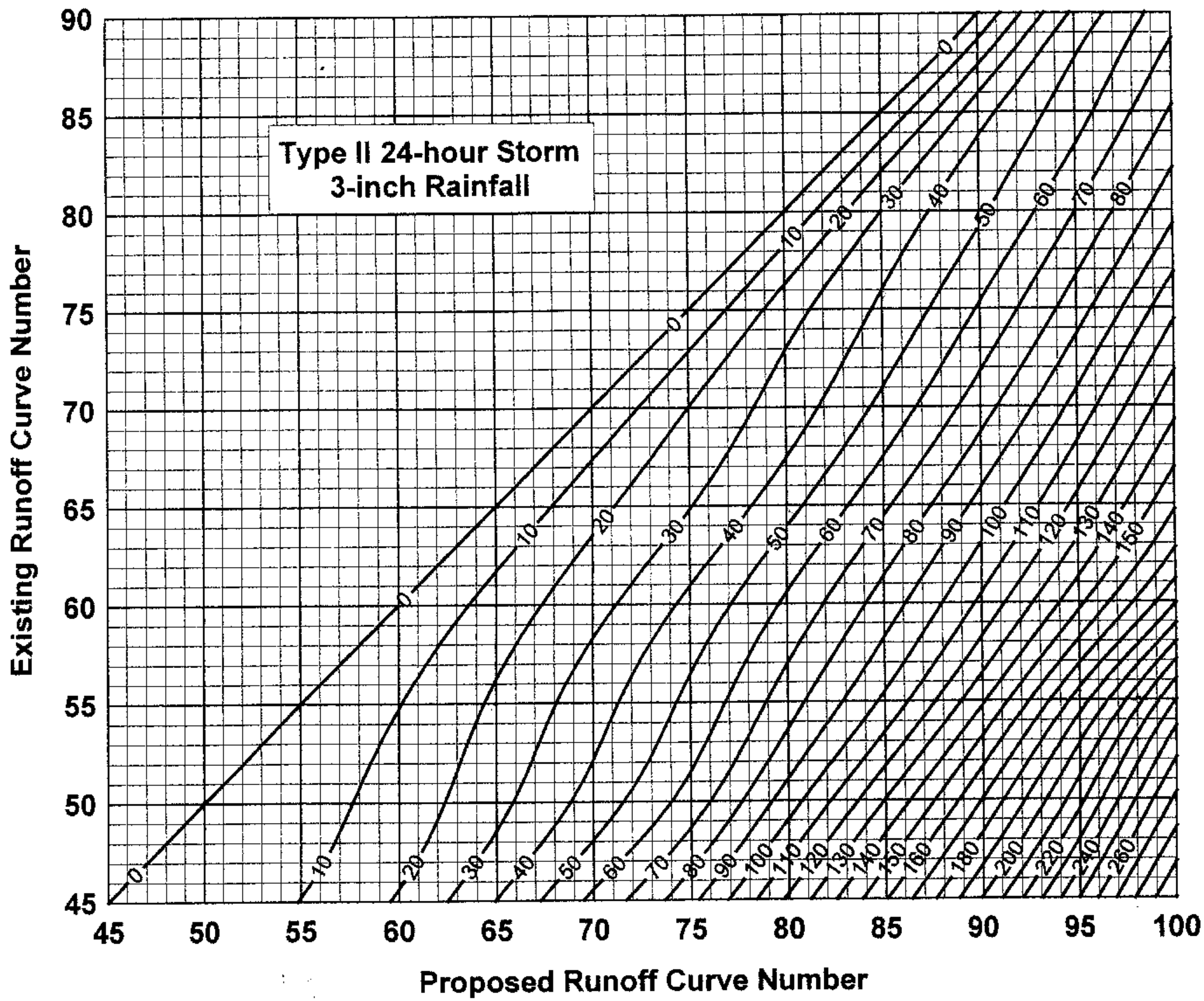
Storage Required to Maintain Pre-Development Peak Runoff Rate Using 100% Detention (hundredths of an inch)



Storage Required to Maintain Pre-Development Peak Runoff Rate Using 100% Detention (hundredths of an inch)



Storage Required to Maintain Pre-Development Peak Runoff Using 100% Detention (hundredths of an inch)



Storage Required to Maintain Pre-Development Peak Runoff Rate Using 100% Detention (hundredths of an inch)